Denitrification in seawater recirculating aquaculture systems using an up-flow sludge blanket reactor

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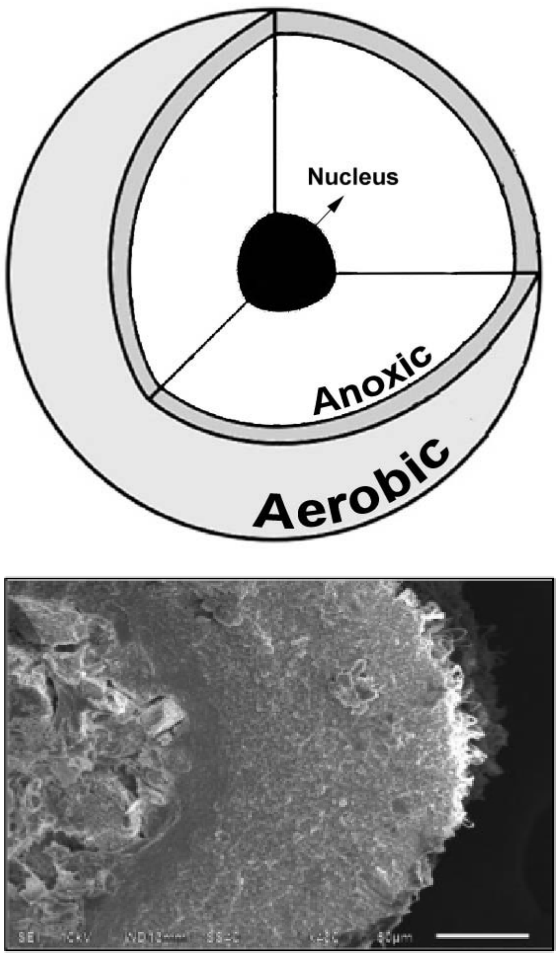
Up-flow sludge blanket

Granular sludge



Franco et al. (2006)

Advantages

- More biomass in less volume
- Versatile, possibility to perform different processes in the same reactor
- No biomedia required
- Especially appropriate for soluble, low solids wastewater
- **Higher denitrification rates per reactor volume**

Objectives and Experiments

Phase I: Granulation

Development of granular sludge

250 mg NO_3-N/L. Batch configuration

as a candidate for d ication in seawater

recirculating a lture systems

Phase II: Capacity evaluation

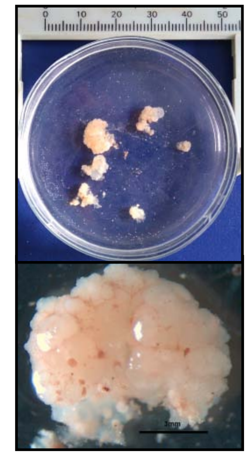
Identification of the maximum denitrification rate testing different upflow velocities

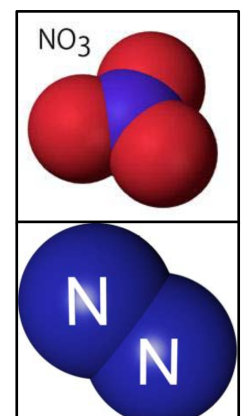
100 mg NO_3-N/L. Flow through configuration

C:N ratio 6 constant

Acetate as carbon source

Seawater

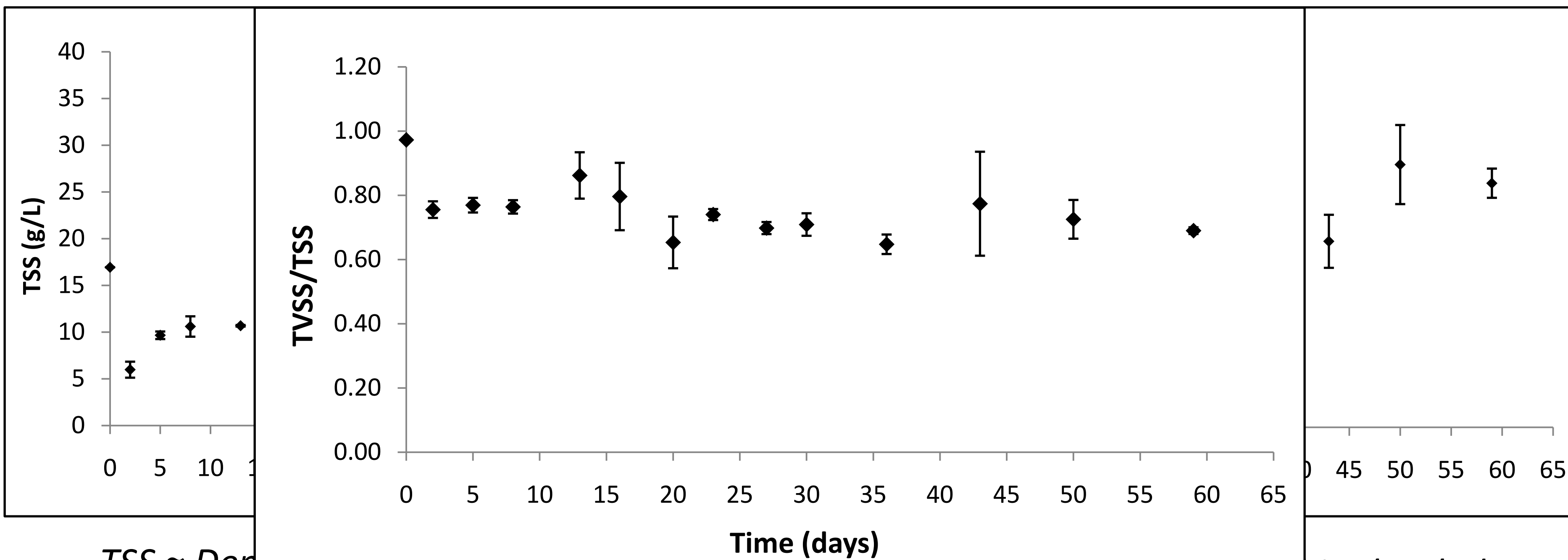




Results Phase I: Total suspended solids and total volatile suspended solids

Increasing density of the sludge

- **Organic** and **inorganic** fractions **increasing** simultaneously over time
- Around **75% organic fraction** (bacteria) through the whole phase



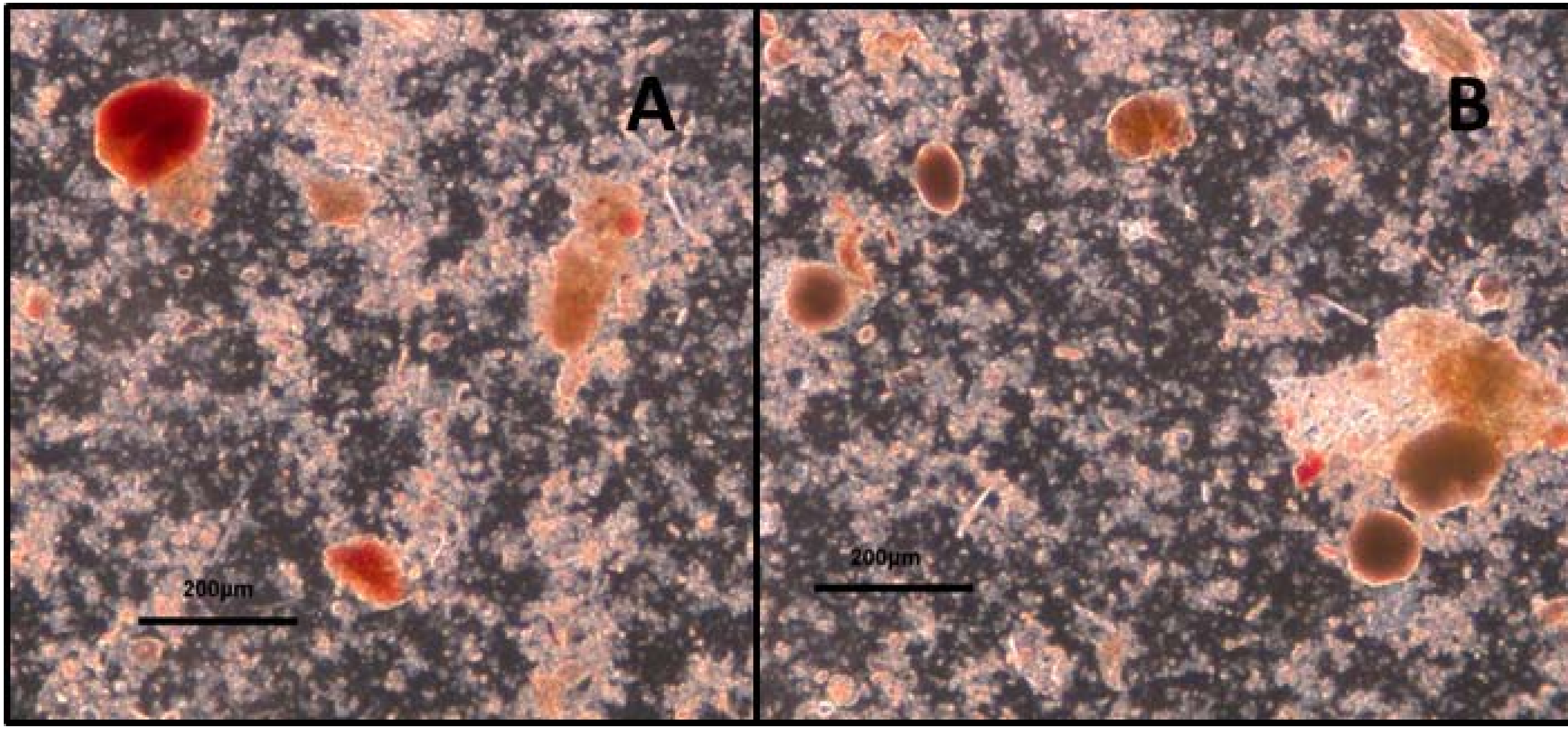
TSS ≈ Density of the granular sludge (Inorganic and organic)

TVSS/TSS = Bacterial fraction within the granular sludge

TVSS ≈ Bacterial density within the sludge

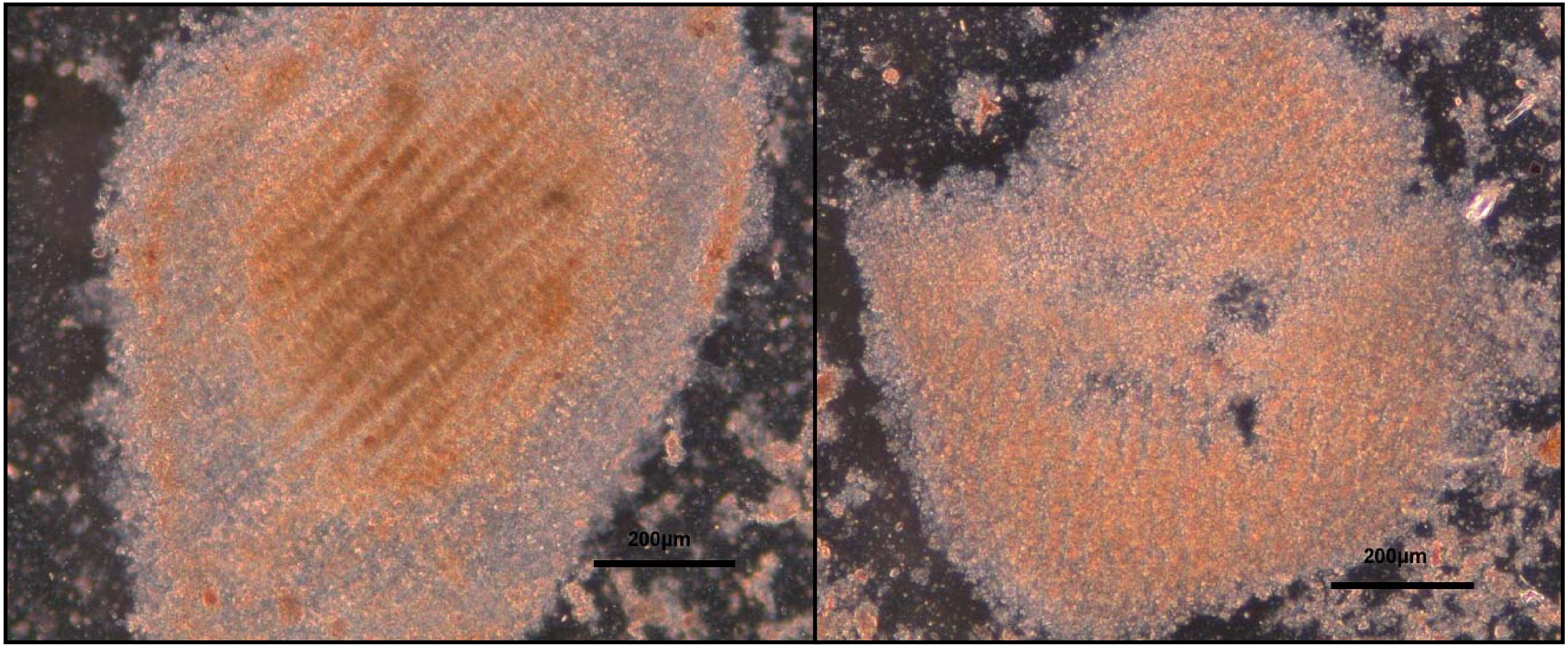
Results Phase I: Granulation

Day 0



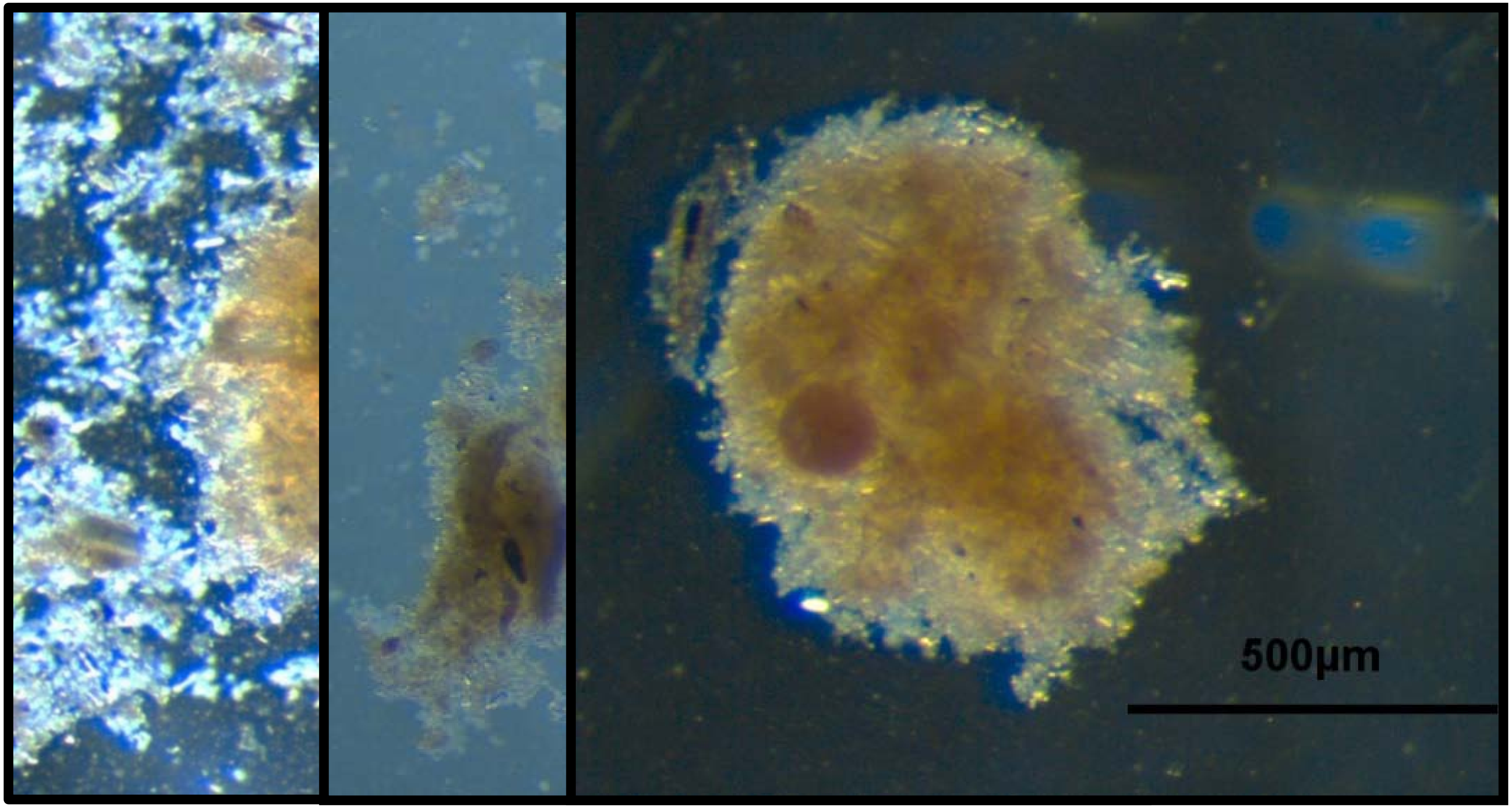
Results Phase I: Granulation

Day 8



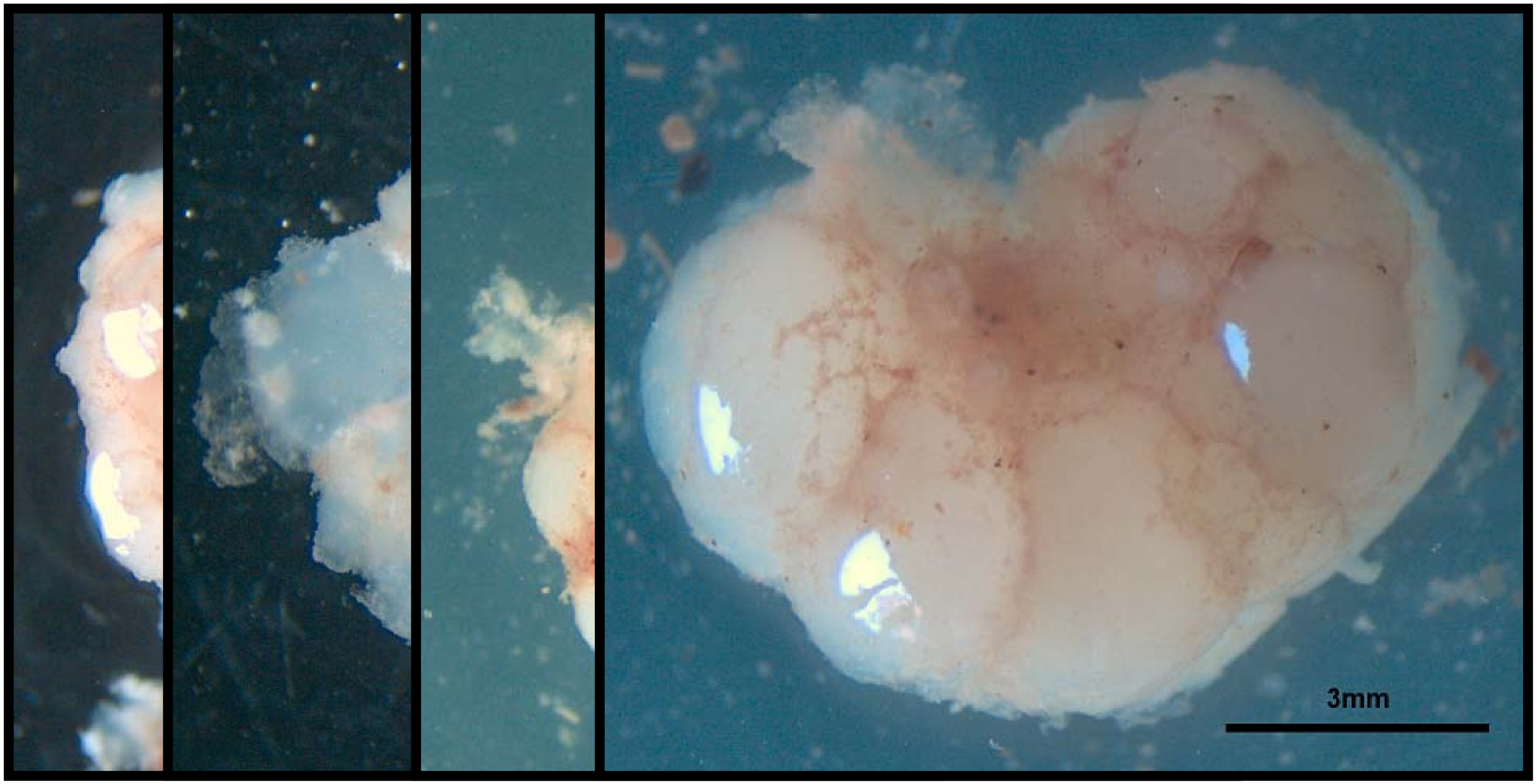
Results Phase I: Granulation

Day 26 Day 36 Day 40



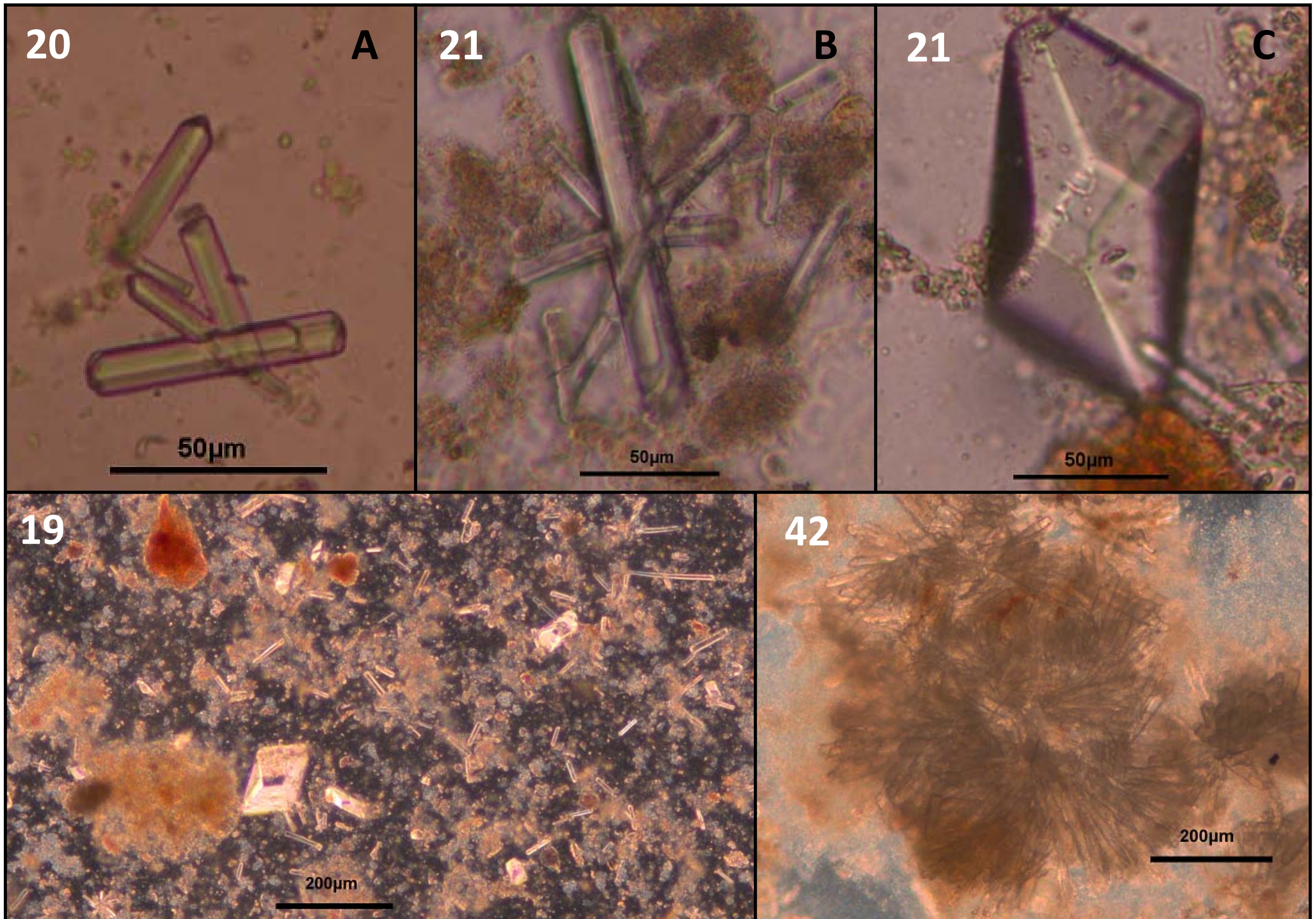
Results Phase I: Granulation

Day 42 **Day 51**



Results Phase I: pH effect and precipitation

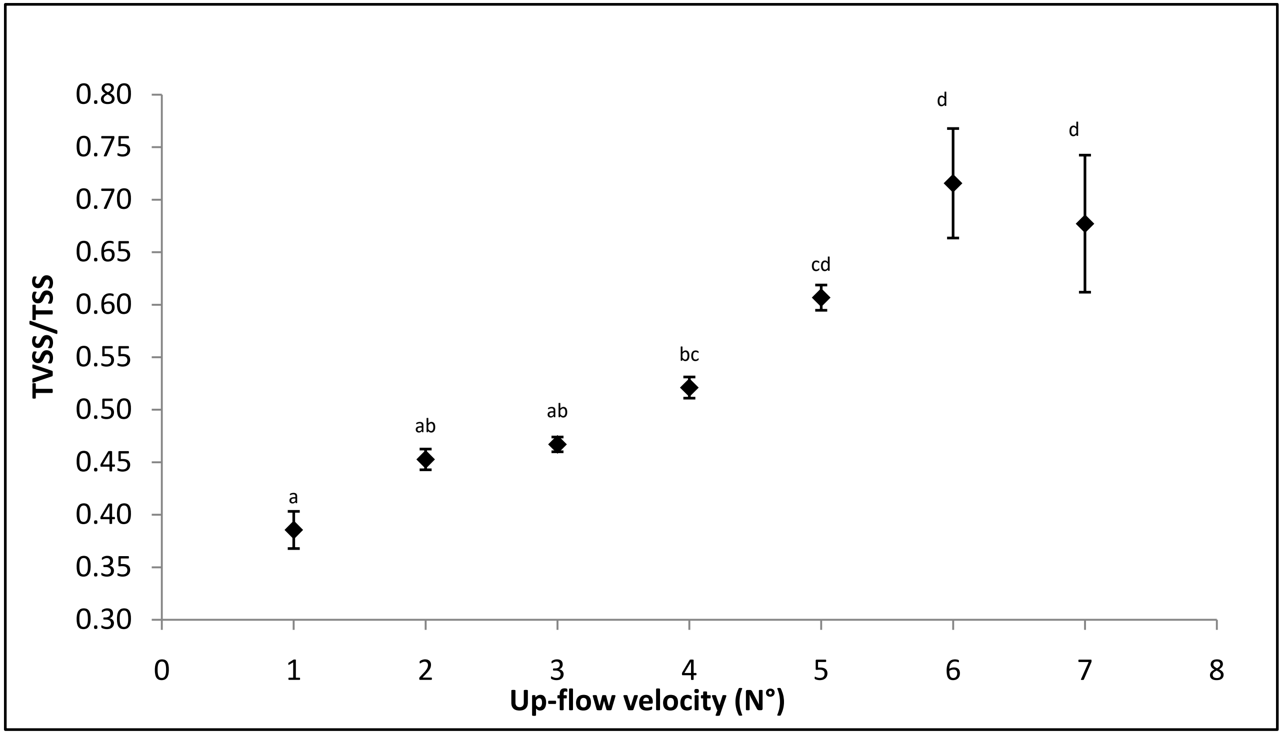
pH from 7.9 to 9.4



Results Phase II: Total suspended solids and total volatile suspended solids

Decreasing density

- **Organic** and **inorganic** fractions **decreasing** over the up-flow velocities
- **Organic proportion** (bacteria) **increasing** over the up-flow velocities

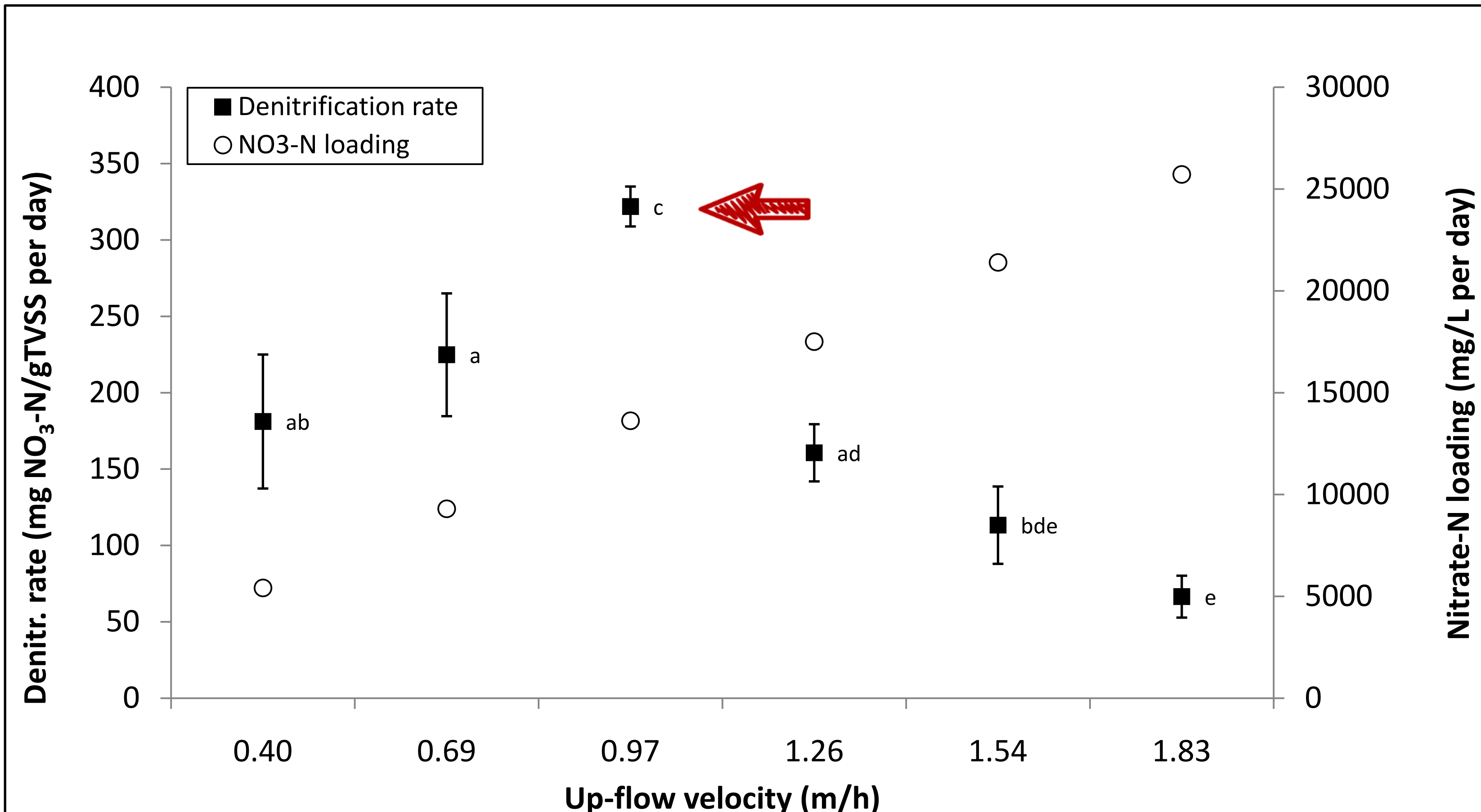


TVSS/TSS = Bacterial fraction within the granular sludge

Results Phase II: Denitrification rate

Maximum denitrification **rate 321.9 ± 13.7 mg NO_3^--N/g TVSS per day @ 0.97 m/h**

Equivalent to **14.9 kg Nitrate-N** per **cubic meter of granular sludge per day**



Contextualization and dimensioning

Inputs

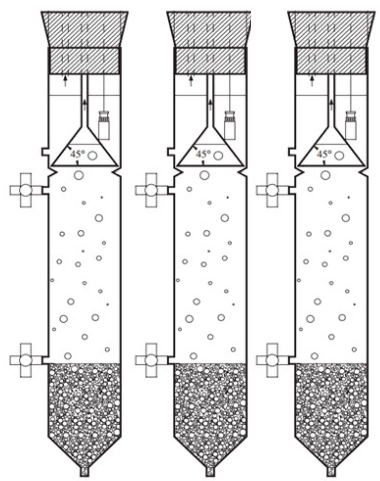
- 1,000 tons/year
- FCR 1.1

Dalsgaard & Pedersen (2016)

Output

54 kg NO_3-N/day

3.65 m³ of granular sludge would be required to **remove 100% of Nitrate**



3 Reactors of 4.8 m diameter would be required to treat **1,500 m³/day**

Conclusions and future perspectives

DTU

- Successful development of **anoxic granular sludge** using an upflow sludge blanket, **seawater** and **wastes** from **marine RAS**
- **Mineral content** in seawater in addition to **high pH aids** the granulation process
- **High denitrification rates** can be achieved using an **up-flow sludge blanket**

To improve

- Granule stre
- Optimize upflow
- Reactors desi dimension

Up-flow sludge blanket: promising candidate for denitrification of effluents from seawater RAS

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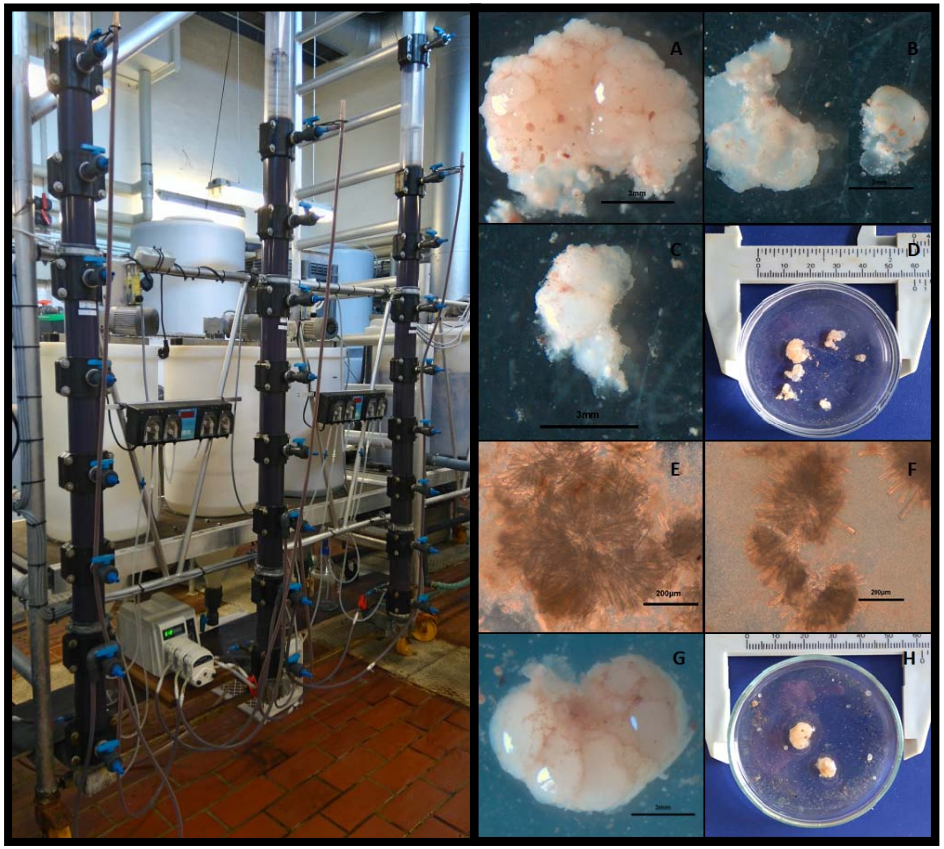

Thank you for your attention